Introduction to ARMS Risk Methodology and Implementation at American Airlines

Topics of Discussion

1. Update on American Airlines SMS
2. AA Corporate Risk Assessment Matrix
3. Introduction to ARMS Risk Methodology
4. Implementation of ERC at AA
5. Implementation of Bow Tie Predictive Risk Modeling at AA

American Airlines Safety Management System

1. January 2008 – Joined FAA SMS Pilot Program and began DGA

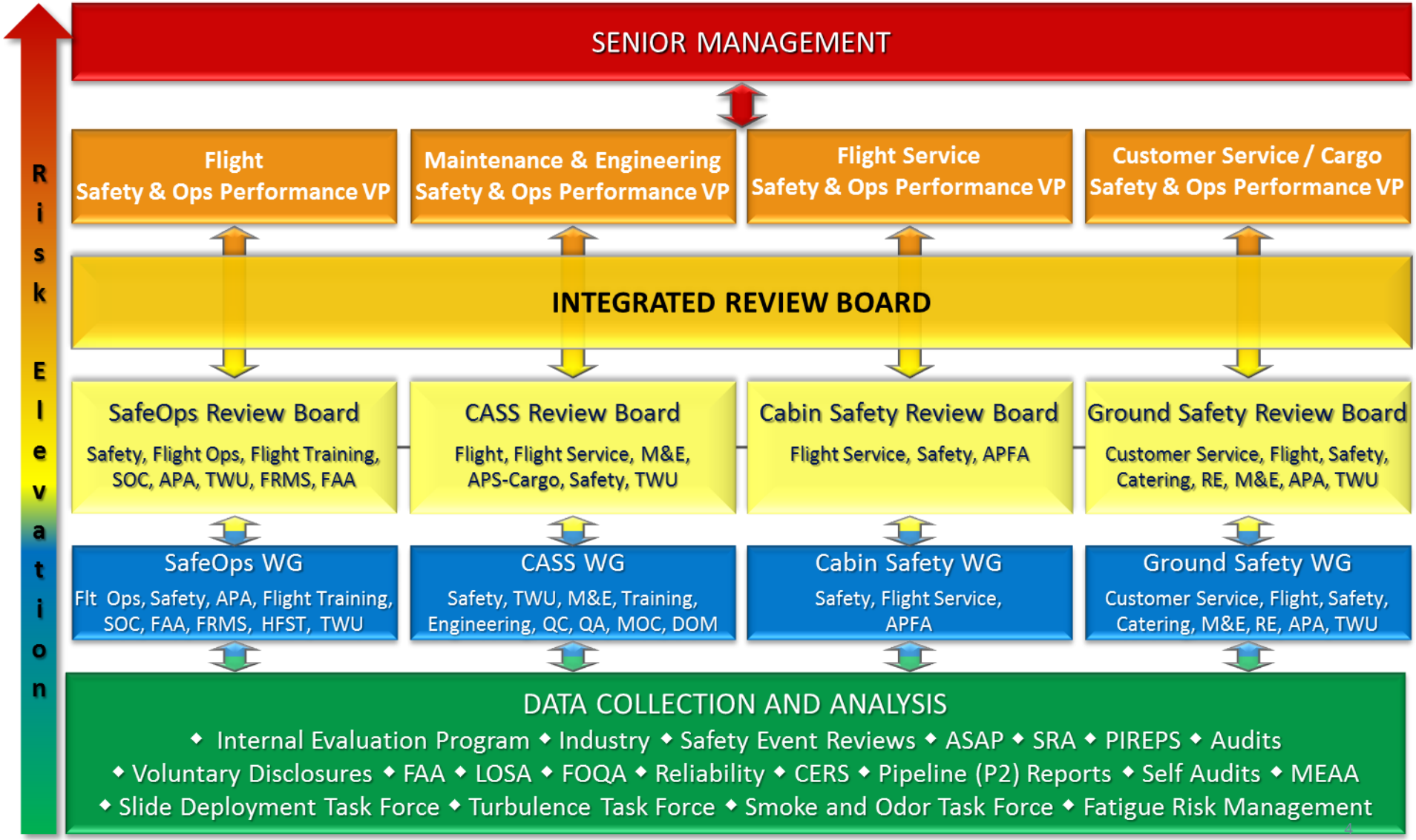
2. June 2012 – Achieved Level IV – Continuous Improvement Status

   Expanding Just Culture and ASAP
   Incorporating ARMS and Bow Tie risk methodology
   Implementing Maintenance LOSA

3. 2013 - Pending merger with US Airways – also Level IV SMS

   Gap Analysis between two strong Safety Management Systems
   Adopt and Go philosophy with future continuous improvement

SMS Stakeholder Review Process



American Airlines Safety Management System

American Airlines

RISK ASSESMENT MATRIX

VER 5.0 1/30/2013

	Severity			
Brand	Extended negative national media activity resulting in substantial change to public perception	Short term negative media/internet activity resulting in minor change in public perception	Short term negative media/internet activity resulting in no change in public perception	Isolated negative media/internet activity resulting in no change in public perception
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Operational Events	State of emergency for an operational condition, impacting the immediate safe operation of an aircraft.(i.e. declared emergency, immediate air interrupt, high speed abort)	Condition resulting in abnormal procedures, impacting the continued safe operation of an aircraft. (i.e. special handling without declared emergency, enroute diversion, low speed abort)	Condition resulting in abnormal procedures with potential to impact safe operation of an aircraft. (i.e. battery charger failure, single source of electrical power, slat disagree)	Condition resulting in normal procedures with potential to impact safe operation of an aircraft.(i.e. false indications)
Airworthiness	Returning an aircraft to service and operating it in a non-standard, unairworthy, or unsafe condition.	Returning an aircraft to service and operating it in a non-standard or unairworthy but not unsafe condition.	Returning an aircraft to service in a non-standard, unairworthy or unsafe condition, not operated.	Affecting aircraft or systems reliability above established control limits but no affect on airworthiness or safety of operation of an aircraft.
Systems or Processes	Loss or breakdown of entire system, subsystem or process.	Partial breakdown of a system, subsystem, or process.	System deficiencies leading to poor dependability or disruption.	Little or no effect on system, subsystem or process.
Audit Finding	Safety	Non-Compliance	Non-Conformance	Concern
OSHA	Willful	Repeat	Serious	General/Other
Regulatory	Major Regulatory Deviation.	Moderate Regulatory Deviation.	Minor Regulatory Deviation.	Policy and/or Procedure Deviation.

Likelihood			I	II	III	IV
Multiple findings during audit and found on previous audit	Likely to occur (Will occur in most circumstances, not surprised if it happens) 51-100% *Occurs ≥ 1 in 100*	A	High	High	Serious	Moderate
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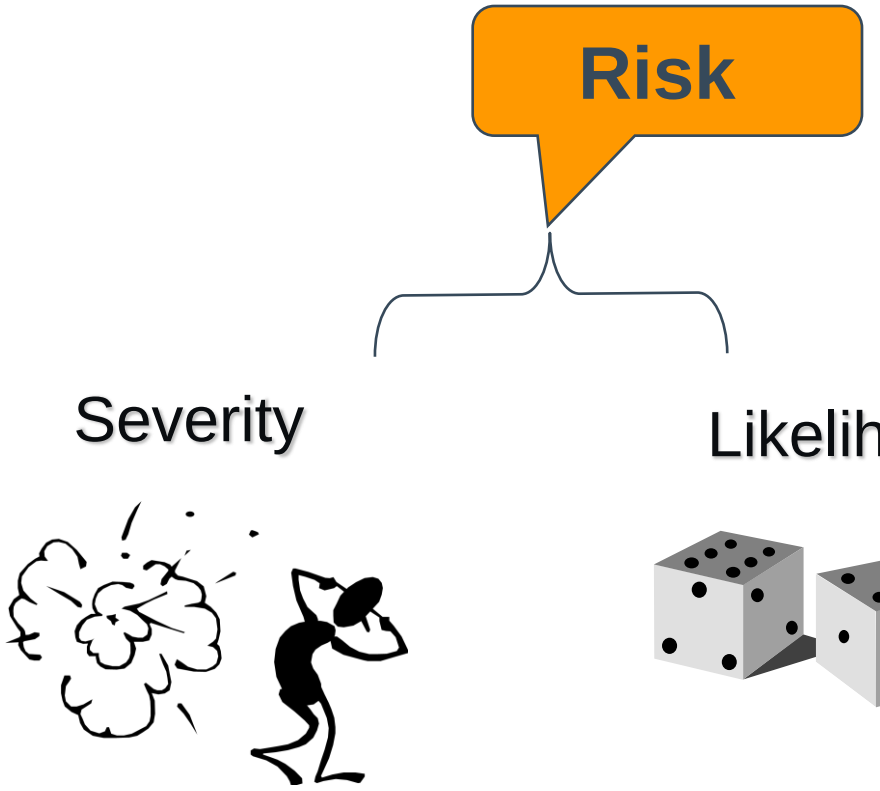
Single finding during audit	Rare to occur (May occur but only in exceptional circumstances, may happen but it would be highly unexpected) 0-1% *Occurs → 1 in 10,000 to 1, 000,000*	D	Moderate	Minor	Low	Low

What is Risk?

Risk is virtually anything that can threaten or limit your ability to meet your objectives.

When people, objects, materials, activities, processes, etc. interact with the hazard, then it can lead to a risk.

How is Risk Measured?



of the level of severity or consequence occurring

ARMS Working Group Mission

To produce useful and cohesive Operational Risk Assessment methods for airlines and other aviation organizations and to clarify the related Risk Management processes.

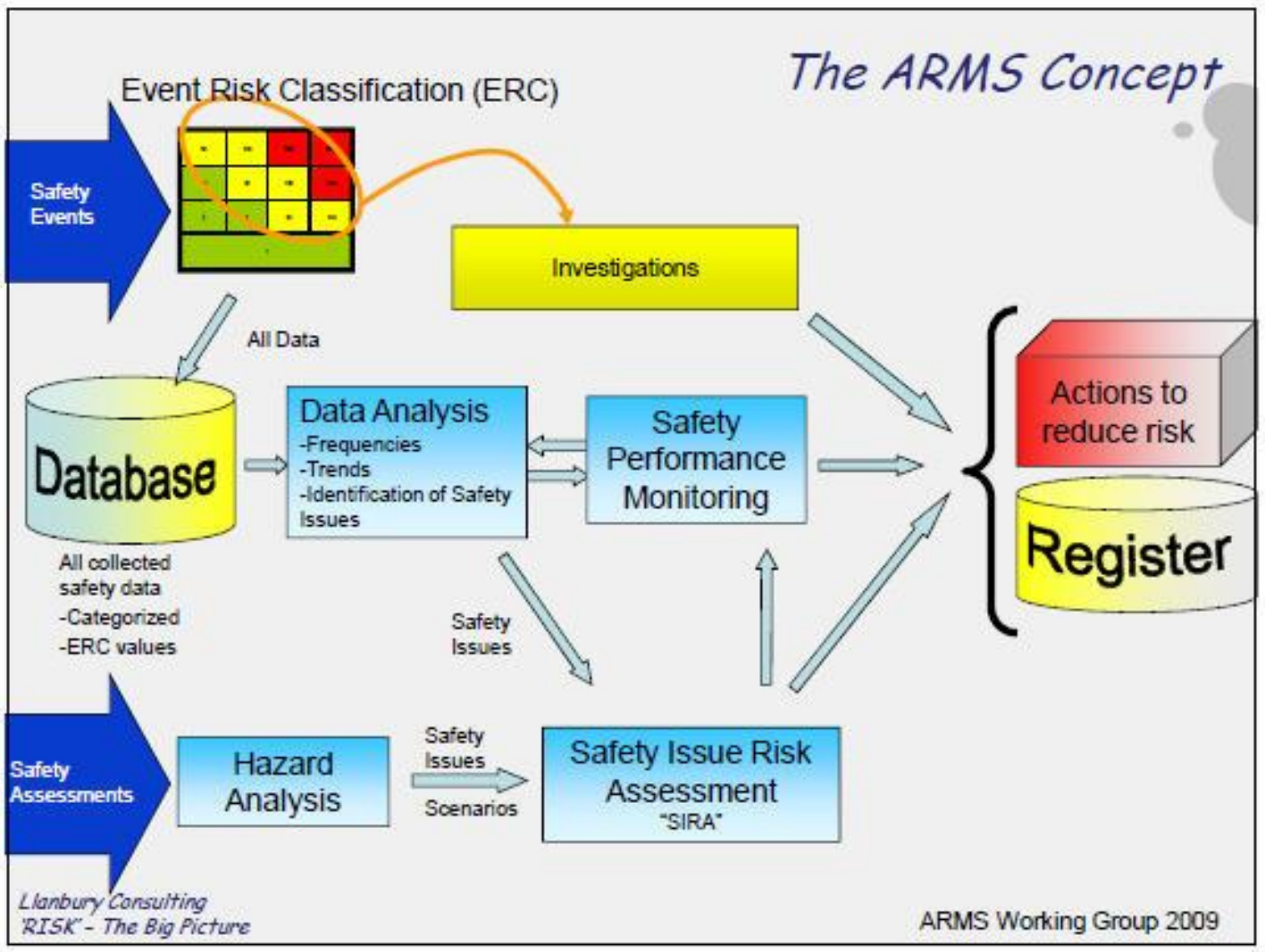
- Understanding the risk of the things that happen.
- Assessing the risk of things that may happen.
- Being able to do quantitative risk analysis.
- Being able to compare risk across aviation.

ARMS Risk Methodology

- A group of international aviation safety experts came together in 2007 to discuss the lack of practical tools and guidance for effective risk management.

- Problems with current risk methodologies:
  - Confusion between likelihood and severity
  - Subjectivity involved in the assessment
  - No common scale to measure risk

ARMS Risk Methodology



Event Based Risk Classification

- If past events are historical facts, how can they be *risk assessed*, as there should be *no uncertainty*?
  - The severity is known and the likelihood of the event is 100%.

- ARMS Event Based Risk (EBR) is the risk that *was* present in the event *in the moment it took place*.

- The two dimensions of EBR are:
  How bad could it have been?
  X *How close did it get?*
  = Event Risk

- In other words: What was the Remaining Safety Margin, i.e. effectiveness of *remaining* controls.

- Or, to put it another way, you want to know how much risk this event carried when it occurred.

Event Based Risk Classification

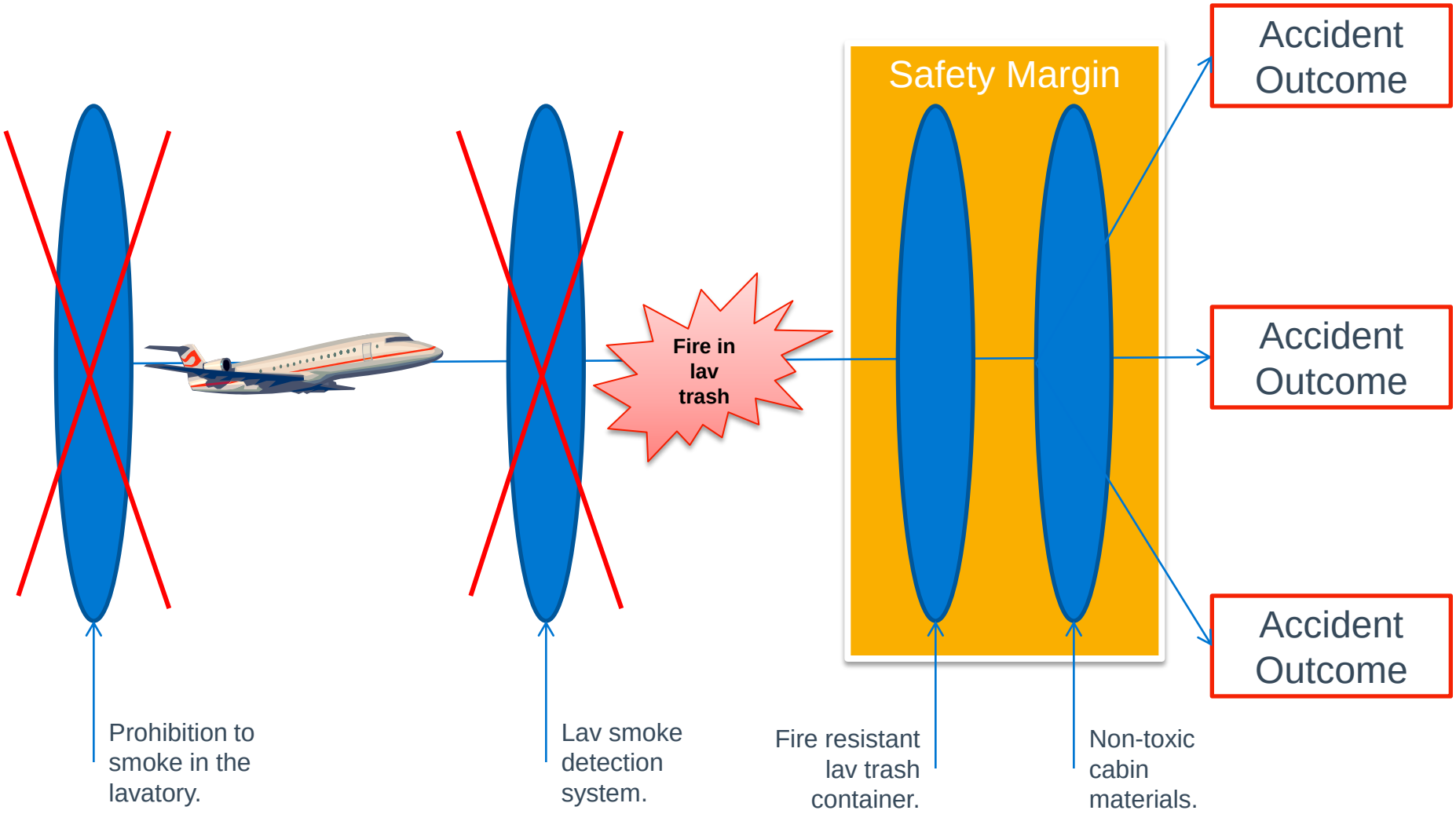
- So this is Risk Classification – NOT Risk Assessment

severity of the potential accident outcome + probability of the event resulting in that outcome*

= Risk

*probability of occurrence is derived from data

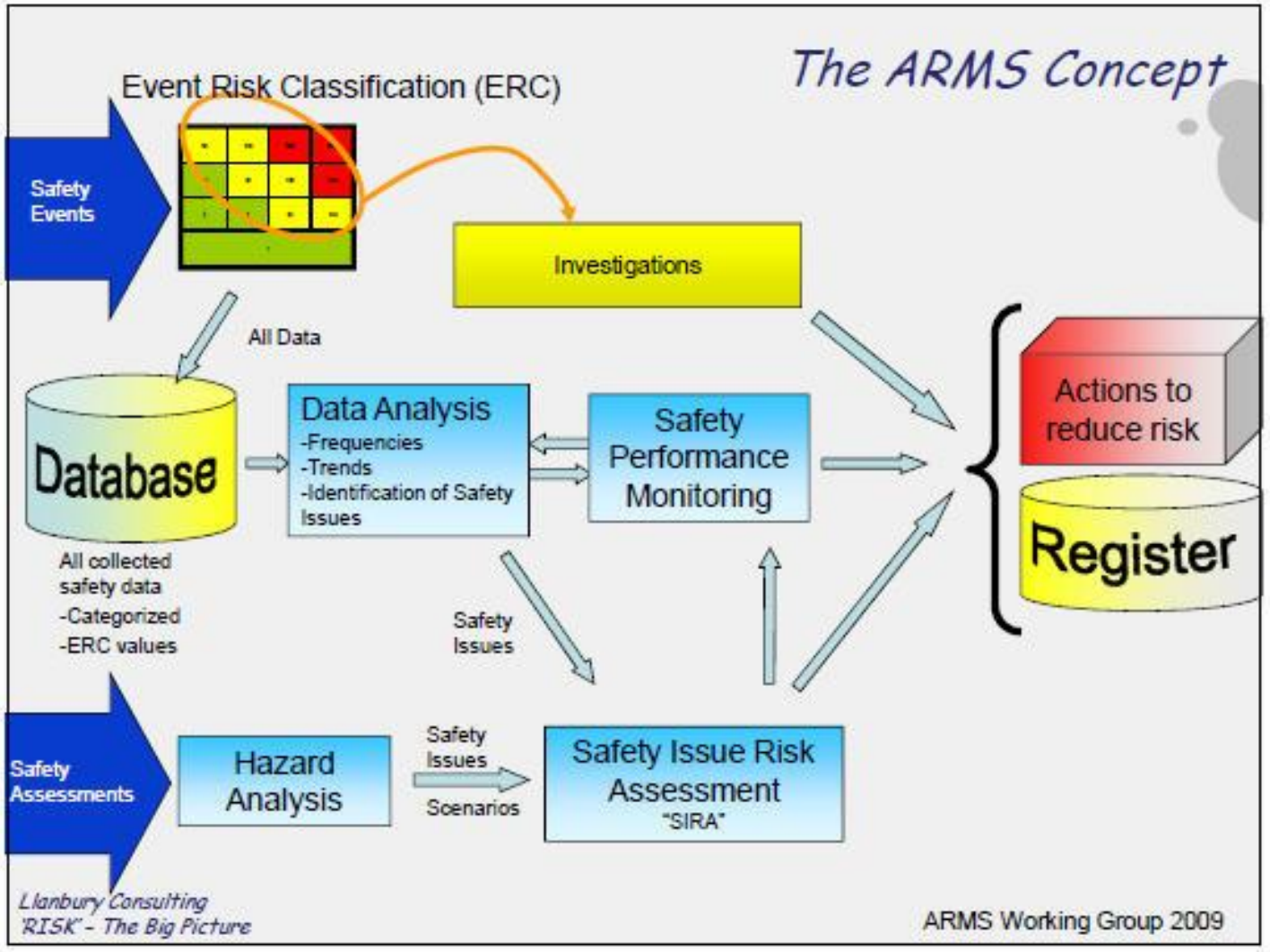
Event Based Risk Classification



Event Based Risk Classification

Question 2: What was the effectiveness of the remaining barriers between this event and the accident scenario?				Question 1: If this event had escalated into an accident, what would have been the most credible accident outcome?
Effective	**Limited**	**Minimal**	**Not Effective**	
2	20	200	2000	**Catastrophic accident with multiple fatalities**
1	10	100	1000	**Few fatalities, multiple serious injuries, major damage/loss to the aircraft**
0.1	1	10	100	**Minor injuries, minor damage to aircraft**
0.01				**No potential damage or injury could occur**

ARMS Risk Methodology

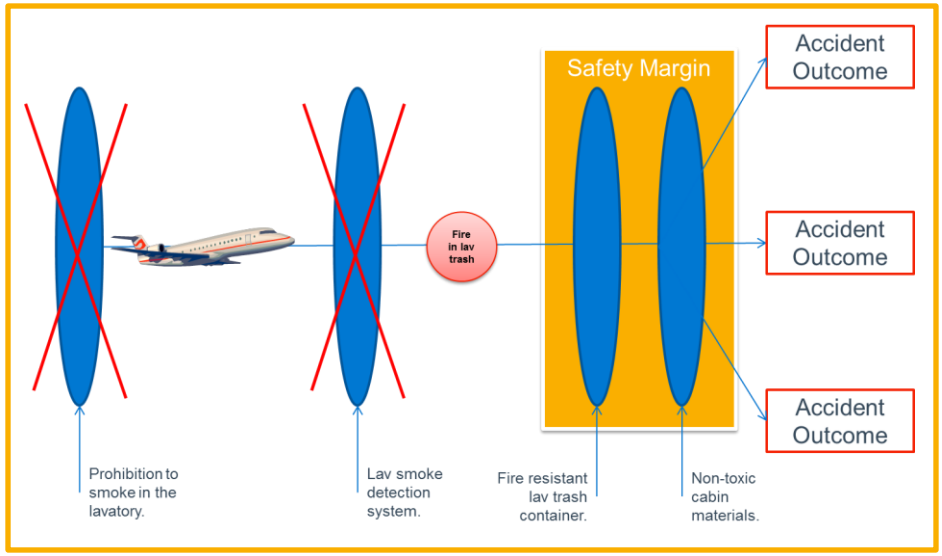


Safety Issue Risk Assessment (SIRA)

- Risk Assessment is the identification of your hazards combined with an evaluation of the risk that those hazards represent to your operation.

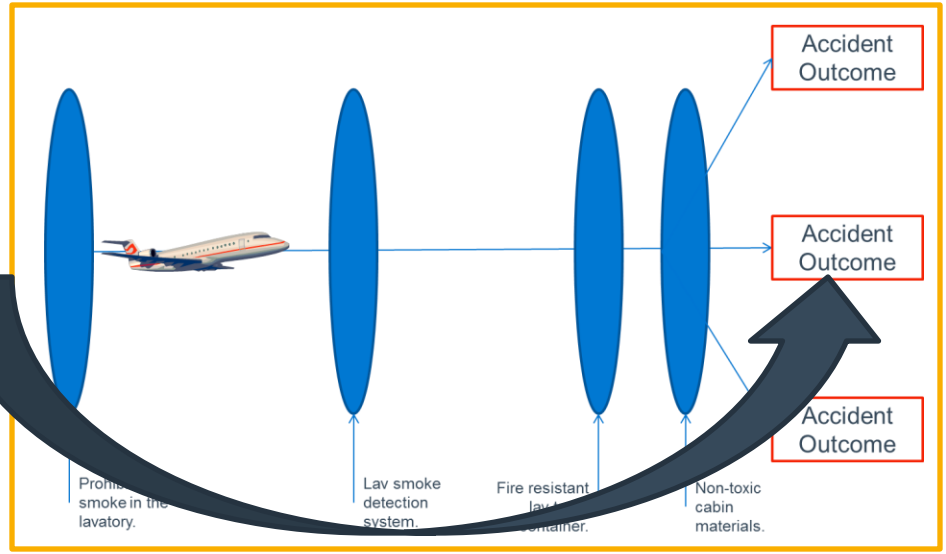
ERC versus SIRA

ERC
for one event



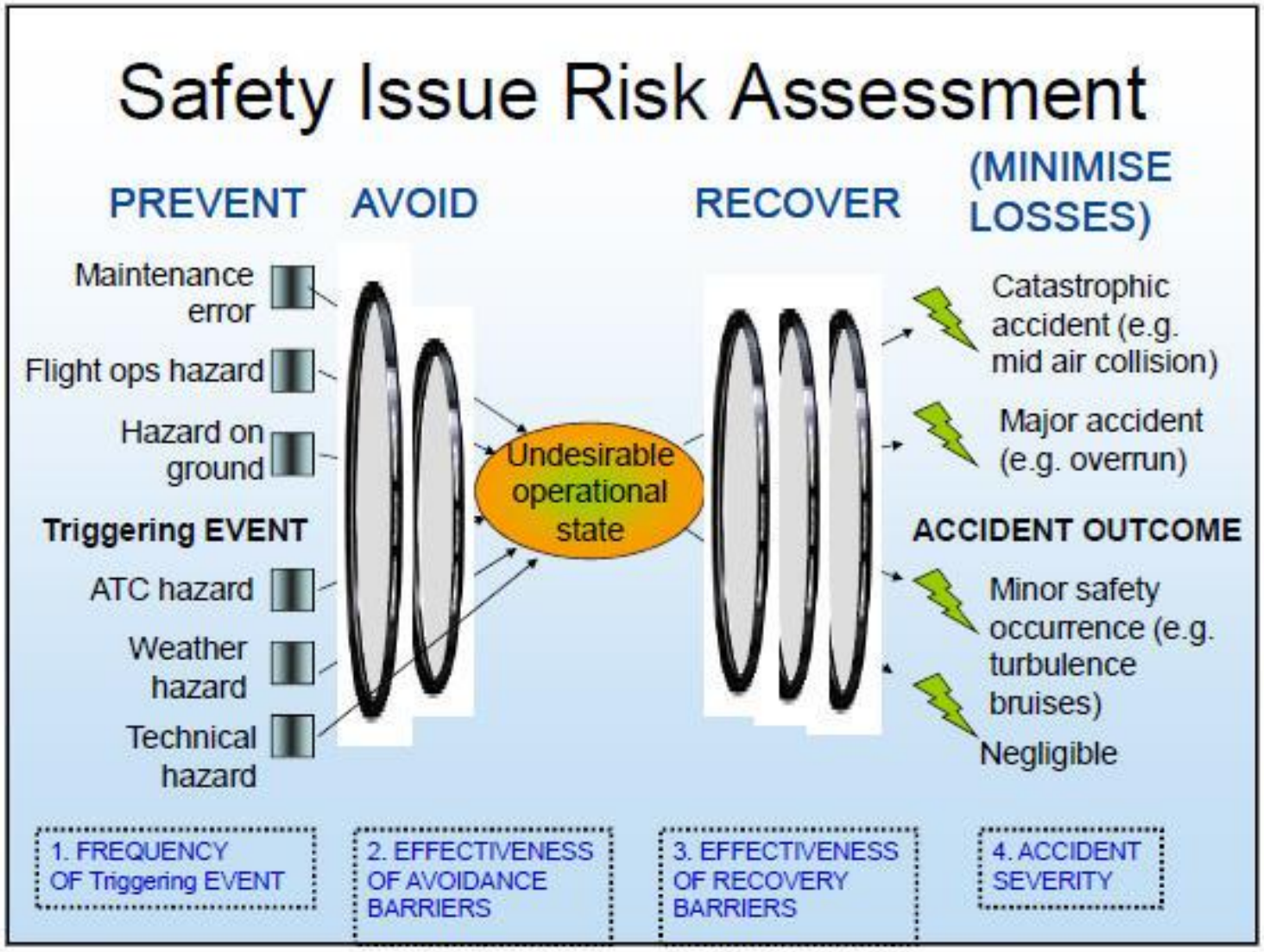
ERC measures the risk of this escalation: in the conditions where the event took place.

SIRA
for Safety Issue

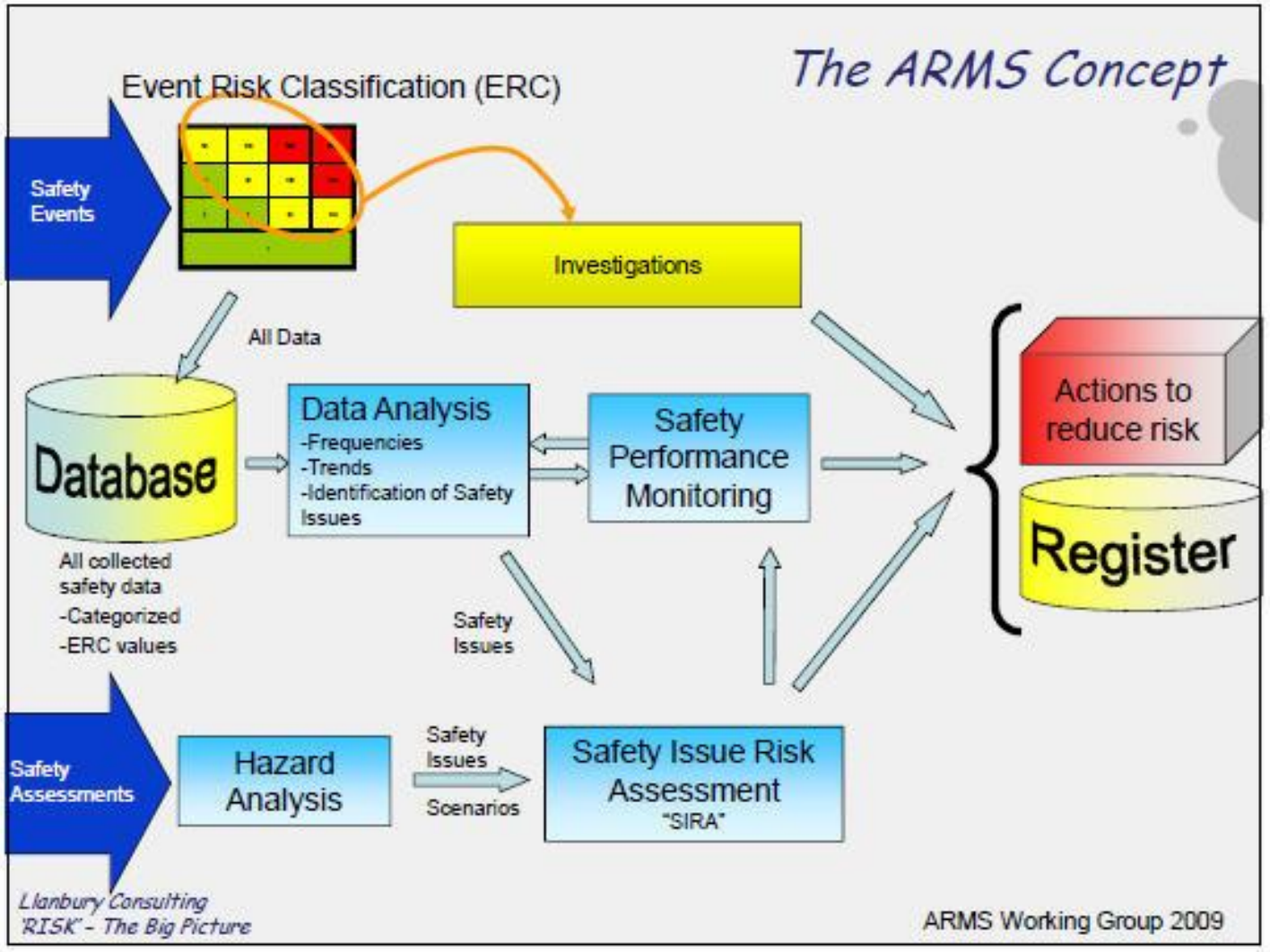


SIRA measures the risk of the whole scenario.

Safety Issue Risk Assessment (SIRA)



ARMS Risk Methodology



Application of ARMS Risk Methodology at American Airlines

AA Event Risk Assessments

American Airlines

Event Risk Assessment Matrix

Potential Adverse Outcome	If the event had escalated, what would have been the **most credible** outcome?				
		I	II	III	IV
	Employee or Customer Injury	Fatality or serious injury total disability or loss of capacity	Immediate admission to hospital as an inpatient and/or partial disability/loss of capacity	Injury requiring first aid treatment or ongoing treatment, with no permanent disability/ loss of capacity	No accident outcome – No potential for injury could occur
	Accident or Damage	Accident with significant damage to aircraft or property	Serious incident with substantial damage to aircraft or property	Incident with minor aircraft or property damage	No accident outcome – No potential for damage could occur

Control Effectiveness						
What was the effectiveness of the remaining controls between this event and the **most credible** outcome?	**Not Effective** The only thing separating this event from an accident was pure luck or exceptional skill, which is not trained or required.	A	High	High	Serious	Low
	Minimal Some controls left but their total effectiveness was minimal	B	High	Serious	Moderate	
	Limited An abnormal situation, more demanding to manage, but with still a considerable remaining safety margin	C	Serious	Moderate	Minor	
	Effective Consisting of several good controls	D	Moderate	Minor	Minor	

Sample Event Risk Classification

Event Review:
Towing of a 777 from a terminal gate commenced before the servicing of the aft lav was completed by ramp service personnel. As the a/c was pushed backward, the service agent crouched in the lift basket as the rail contacted the VHF antenna at the lowest point on the fuselage. The push was stopped after approximately 10-15ft of travel.

Most Credible Escalated Consequence:
Pinching injury between lav service lift and fuselage.

Q1	Consequence	If the event had escalated, what would have been the most credible outcome?
Employee or Customer Injury	II	Injury requiring ongoing treatment, with no permanent disability/loss of capacity.
Q2	**Control**	**What was the effectiveness of the remaining controls between this event and the most credible outcome?**
Not Effective	A	The only thing separating this event from an accident was pure luck or exceptional skill, which is not trained or required.

	Risk
The railing of the lav lift contacted the VHF antenna at the lowest portion of the fuselage. Even if a/c movement had continued another 10-15ft, an occupant of the lift would have been clear of the lowest point of the a/c belly making the most credible injury pinching of an extremity between the lift railing a/c fuselage.	High

Point in time when Barrier over the hazard is lost.

Event:
Aircraft towing begun before lav servicing is finished.

A possible cause that can release the Hazard by producing the Top Event

Hazard/Threat:
Failure to adhere to written tow procedures. Channelized attention by push crew. Injury to service personnel due to uncoordinated aircraft movement.

A potential event resulting from the release of a Hazard, which directly results in loss or damage

Consequence:
Ramp service agent escaped pinching injury by crouching in lav service lift. Minor damage to a/c.

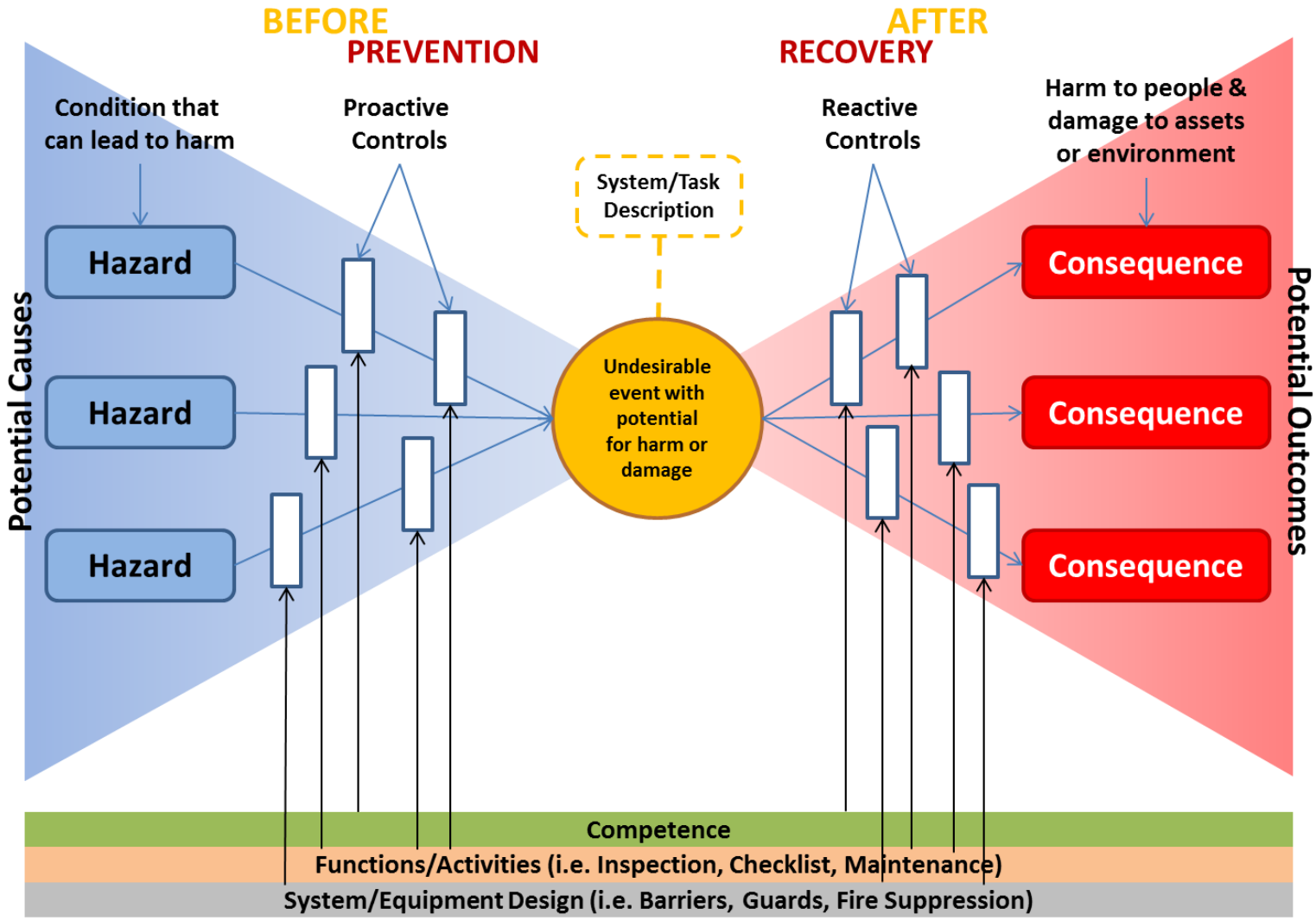
A function that prevents or influences a real chain of events in an intended direction

Control(s):
GPM 4.11 ground movement guide, Goldhofer checklist, walk around procedures, crew coordination, communication procedures during push.

An indication of size/extent

Scale:
Distance of travel was 10-15ft.
Basket rail contacted belly at
Lowest point. (VHF antenna)

AA Bow Tie Methodology



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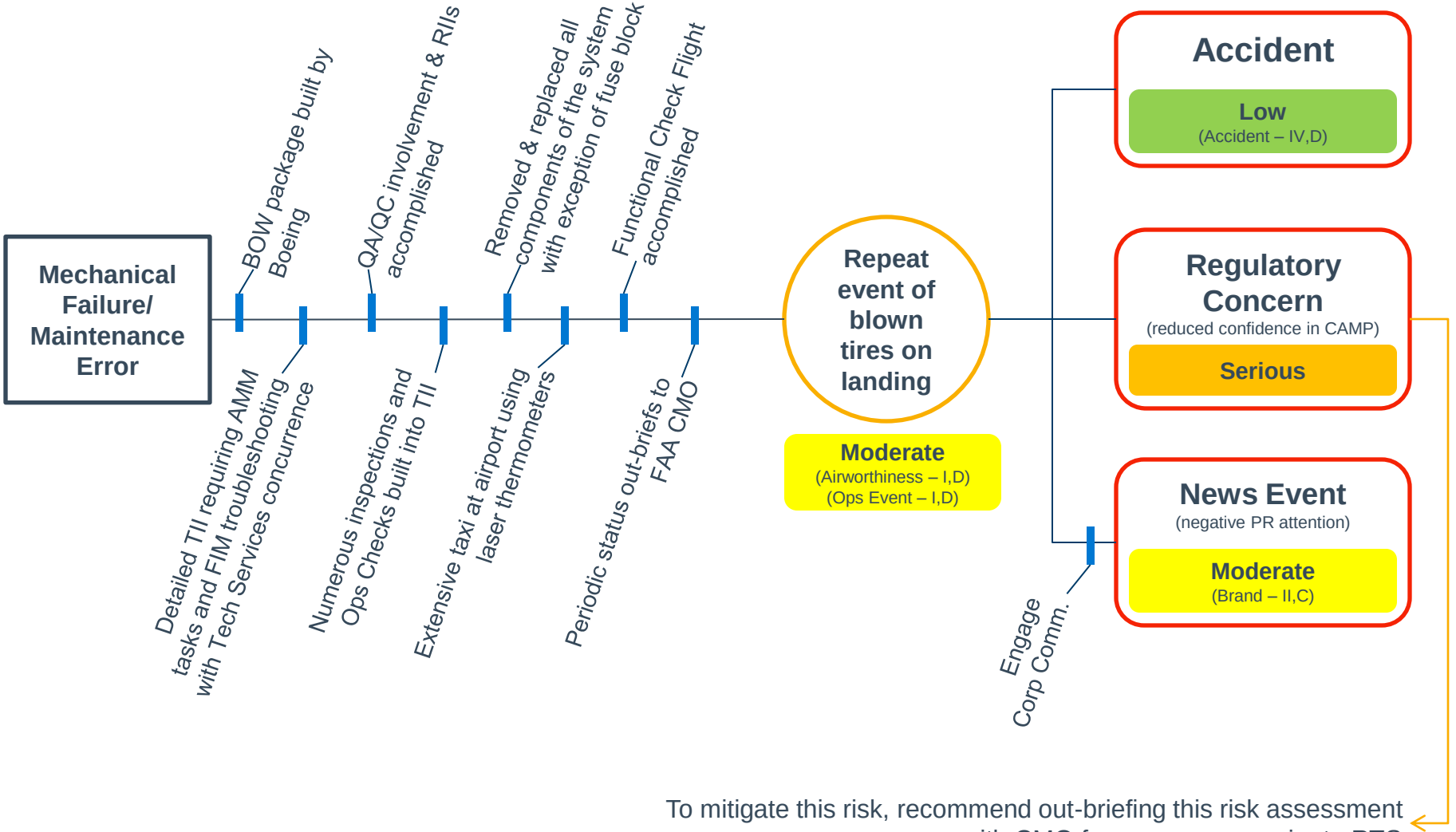

To mitigate this risk, recommend out-briefing this risk assessment with CMO for concurrence prior to RTS.

Pros and Cons

1. All risk assessments focus on the effectiveness of risk controls.
2. ERC removes much of the subjectivity, but not all.
3. ERC provides a measurable safety performance metric and reflection of the true safety state of the operation.
4. SIRA/Bow Tie provide an effective means of visually communicating risk in the operation and the risk mitigation plan.
5. Still need to test the methodology and quantitative measurements.

Questions or Comments?

Thank you,

Candra Schatz
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American Airlines
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